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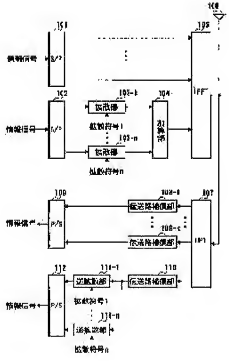
(54) OFDM COMMUNICATION UNIT AND OFDM COMMUNICATION METHOD



(57)Abstract:
PROBLEM TO BE SOLVED: To provide an OFDM communication unit that can enhance a transmission efficiency while suppressing an error rate characteristic of an information signal.
SOLUTION: Spread sections 103-1-103-n apply spread processing to information signals of a plurality of sequences from an S/P 102. An adder section 104 sums signals subjected to the spread processing from the spread sections 103-1-103-n to generate a DS-CDMA information signal. An IFFT section 105 assigns the generated DS-CDMA information signal to a DS subcarrier to conduct frequency division multiplex processing.

CLAIMS

[Claim(s)]
[Claim 1]An OFDM sending set comprising:
A creating means which generates a diffusion signal by performing diffusion treatment to an information signal.
A Frequency-Division-Multiplexing means to perform Frequency-Division-Multiplexing processing by assigning said diffusion signal to a direct-current subcarrier.

[Claim 2]The OFDM sending set comprising according to claim 1:
A conversion method from which a creating means changes an information signal into a signal of a plural series.
A diffusion means which performs diffusion treatment using a spread code peculiar to a signal to a signal of said plural series, and an adding means which generates a diffusion signal by adding a signal of said plural series in which diffusion treatment was carried out by said diffusion means.

[Claim 3]An OFDM receiving set comprising:
A reception means which receives a signal transmitted by the OFDM sending set according to claim 1 or 2.
The Fourier conversion process means which takes out a diffusion signal transmitted by direct-current subcarrier by performing the Fourier conversion process to a signal received by said reception means, and an extraction means to extract an information signal by performing back-diffusion-of-gas processing to a taken-out diffusion signal.

[Claim 4]The OFDM receiving set comprising according to claim 3:
A back-diffusion-of-gas means to extract an information signal of a plural series when an extraction means performs back-diffusion-of-gas processing using a spread code peculiar to a signal to a diffusion signal taken out by the Fourier conversion process means.
A conversion method which changes an information signal of said plural series into an information signal of one series.

[Claim 5]A communication terminal device comprising:
The OFDM sending set according to claim 1 or 2.
The OFDM receiving set according to claim 3 or 4.

[Claim 6]A base station device comprising:
The OFDM sending set according to claim 1 or 2.
The OFDM receiving set according to claim 3 or 4.

[Claim 7]An OFDM transmission method comprising:
A generation process of generating a diffusion signal by performing diffusion treatment to an information signal.
A Frequency-Division-Multiplexing process of performing Frequency-Division-Multiplexing processing by assigning said diffusion signal to a direct-current subcarrier.

[Claim 8]An OFDM receiving method comprising:
A receiving process which receives a signal transmitted by the OFDM transmission method according to claim 7.
The Fourier conversion process process of taking out a diffusion signal transmitted by direct-current subcarrier by performing the Fourier conversion process to a signal received in said receiving process, and an extraction process of extracting an information signal by performing back-diffusion-of-gas processing to a taken-out diffusion signal.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the communication apparatus of an OFDM (Orthogonal Frequency Division Multiplexing) method especially about the communication apparatus used for a digital mobile communications system.
[0002]
[Description of the Prior Art]These days, the communication apparatus (following "OFDM communication device") of the OFDM system is examined briskly. Hereafter, the conventional OFDM communication device is explained with reference to drawing 3. Drawing 3 is a block diagram showing the composition of the conventional OFDM communication device. Here, the total of the subcarrier (subcarrier) to be used is set to k as an example.
[0003]With reference to drawing 3, the information signal of one series (serial) is changed into the information signal of the plural series (parallel) of only the total subcarrier by the S/P converter 1 in a transmission system. That is, the information signal of one series is changed into k signals of the information signal 1 - the information signal k by the S/P converter 1. The information signal changed into the plural series is sent to the IFFT (Inverse Fast Fourier Transform) section 2.
[0004]In IFFT part 2, Frequency-Division-Multiplexing processing is performed by making IFFT (inverse Fourier transform) processing to the information signal of a plural series. Specifically by IFFT part 2, the subcarrier for which only the number corresponding to the total number of subcarriers was prepared is assigned to the information signal into which it was changed by the plural series (if it puts in another way). The information signal changed into the plural series is arranged to the subcarrier for which only the number corresponding to the total number of subcarriers was prepared, and Frequency-Division-Multiplexing processing is performed. How to assign a subcarrier is as being shown in drawing 4. Drawing 4 is a mimetic diagram showing the situation of arrangement of the subcarrier in the conventional OFDM communication device.
[0005]As shown in drawing 4, k subcarriers are arranged on the frequency axis and the information signal k is assigned to subcarrier k/2 to information signal k/2+1, and subcarrier k/2 at the information signal 1 and the subcarrier 1 at information signal k/2, and the subcarrier 1, respectively.
[0006]With reference to drawing 3, the signal with which the Frequency-Division-

Multiplexing processing in IFFT part 2 was overlapped on the subcarrier to the information signal 1 - the information signal k is acquired again. A sending signal is generated by making predetermined transmitting processing to the signal acquired by Frequency-Division-Multiplexing processing. This sending signal is transmitted to a communications partner via the antenna 3.
[0007]On the other hand, in a receiving system, the signal transmitted by the communications partner is received by this communication apparatus via the antenna 3. The above-mentioned communications partner is provided with the same composition as what is shown in drawing 3.
The sending signal acquired by performing processing in the transmission system mentioned above is transmitted.

[0008]The input signal from the antenna 3 is sent to the FFT (Fast Fourier Transform) section 4, after predetermined reception is made. In FFT section 4, the information signal (namely, k information signals) transmitted by each subcarrier is taken out by performing FFT (Fourier transform) processing to the input signal with which the above-mentioned predetermined reception was made.
[0009]The information signal transmitted by each subcarrier is sent to either of the transmission-line compensation parts (namely, the transmission-line compensation part 5-1 - 5-k) in which only the number corresponding to the total number of subcarriers was formed.
[0010]In the transmission-line compensation part 5-1 - 5-k, transmission-line compensation processing (namely, processing which compensates distortion etc. which were produced in the transmission line) is made to the information signal transmitted by each subcarrier. k information signals carried out after transmission-line compensation processing are changed into the information signal of one series (serial) by the P/S converter 6.
[0011]Transmission of an information signal is performed by making the above processings. Here, generally in IFFT part 2 in a transmission system, the subcarrier is not arranged to DC for the following reasons. That is, the subcarrier (henceforth "DC subcarrier (or direct-current subcarrier)") arranged at DC is overlapped on direct-current (DC) offset in the analog circuitry used for a transmission system and a receiving system. For this reason, the error characteristic of the information signal (namely, information signal transmitted by DC subcarrier) arranged at DC subcarrier deteriorates under the influence of direct current offset. For such a reason, as shown in drawing 4, the subcarrier is not arranged to DC.
[0012]
[Problem(s) to be Solved by the Invention]However, there is a problem as shown below in the above-mentioned conventional OFDM communication device. Namely, although degradation of the error rate characteristics of an information signal can be prevented by making it not arrange a subcarrier to DC in the above-mentioned conventional OFDM communication device compared with the case where the subcarrier has been arranged, to DC, Transmission efficiency falls [the part which does not arrange a subcarrier to DC] compared with the case where the subcarrier has been arranged to DC.
[0013]This invention is made in view of this point, and is a thing.
The purpose is providing the OFDM communication device which raises transmission

efficiency, suppressing error rate characteristics.

[0014]
[Means for Solving the Problem]An OFDM sending set of this invention takes composition possessing a creating means which generates a diffusion signal, and a Frequency-Division-Multiplexing means to perform Frequency-Division-Multiplexing processing by assigning said diffusion signal to a direct-current subcarrier, by performing diffusion treatment to an information signal.
[0015]A conversion method from which, as for an OFDM sending set of this invention, a creating means changes an information signal into a signal of a plural series in the above-mentioned composition, Composition possessing a diffusion means which performs diffusion treatment using a spread code peculiar to a signal to a signal of said plural series, and an adding means which generates a diffusion signal by adding a signal of said plural series in which diffusion treatment was carried out by said diffusion means is taken.
[0016]In a receiving side device by arranging and transmitting an information signal which performed diffusion treatment of a direct spread system to a direct-current subcarrier in a transmitting side device according to these composition, Since an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a signal transmitted by direct-current subcarrier can be taken out, it becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.
[0017]An OFDM receiving set of this invention by performing the Fourier conversion process to a signal received by reception means which receives a signal transmitted by an OFDM sending set of one of the above, and said reception means, Composition possessing the Fourier conversion process means which takes out a diffusion signal transmitted by direct-current subcarrier, and an extraction means to extract an information signal by performing back-diffusion-of-gas processing to a taken-out diffusion signal is taken.
[0018]In the above-mentioned composition, an extraction means an OFDM receiving set of this invention by performing back-diffusion-of-gas processing using a spread code peculiar to a signal to a diffusion signal taken out by the Fourier conversion process means, Composition possessing a back-diffusion-of-gas means to extract an information signal of a plural series, and a conversion method which changes an information signal of said plural series into an information signal of one series is taken.
[0019]When an information signal which performed diffusion treatment of a direct spread system performs the Fourier conversion process to a signal which has been arranged and was transmitted to a direct-current subcarrier according to these composition, Since a diffusion signal transmitted by direct-current subcarrier can be taken out and an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a taken-out diffusion signal further can be taken out, It becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.
[0020]A communication terminal device of this invention takes composition possessing an OFDM sending set of one of the above, and an OFDM receiving set of one of the above.

[0021]Since transmission efficiency can be raised according to this composition, suppressing the error rate characteristics of an information signal, a communication terminal device which performs good communication can be provided.
[0022]A base station device of this invention takes composition possessing an OFDM sending set of one of the above, and an OFDM receiving set of one of the above.
[0023]Since transmission efficiency can be raised according to this composition, suppressing the error rate characteristics of an information signal, a base station device which performs good communication can be provided.
[0024]An OFDM transmission method of this invention possessed a generation process of generating a diffusion signal, and a Frequency-Division-Multiplexing process of performing Frequency-Division-Multiplexing processing by assigning said diffusion signal to a direct-current subcarrier, by performing diffusion treatment to an information signal.
[0025]In a receiver by arranging and transmitting an information signal which performed diffusion treatment of a direct spread system to a direct-current subcarrier in the transmitting side according to this method, Since an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a signal transmitted by direct-current subcarrier can be taken out, it becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.
[0026]An OFDM receiving method of this invention by performing the Fourier conversion process to a receiving process which receives a signal transmitted by the above-mentioned OFDM transmission method, and a signal received in said receiving process, The Fourier conversion process process of taking out a diffusion signal transmitted by direct-current subcarrier, and an extraction process of extracting an information signal by performing back-diffusion-of-gas processing to a taken-out diffusion signal were provided.
[0027]When an information signal which performed diffusion treatment of a direct spread system performs the Fourier conversion process to a signal which has been arranged and was transmitted to a direct-current subcarrier according to this method, Since a diffusion signal transmitted by direct-current subcarrier can be taken out and an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a taken-out diffusion signal further can be taken out, It becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.
[0028]
[Embodiment of the Invention]First, this invention person noted performing diffusion treatment of a direct spread system to the information signal arranged to DC subcarrier. When this invention person has arranged the information signal to DC subcarrier, the error rate characteristics of the information signal transmitted by this DC subcarrier deteriorate, but. When the information signal (henceforth "a DS-CDMA information signal") which performed diffusion treatment of the direct spread system has been arranged to DC subcarrier, The DS-CDMA information signal transmitted by this DC subcarrier finds out that direct current offset is reduced by the back-diffusion-of-gas processing at the time of reception, and error rate characteristics will become good, and came to carry out this invention.

[0029]The main point of this invention is having been made to perform diffusion treatment of the direct spread system to the information signal arranged to DC subcarrier (direct-current subcarrier). If it puts in another way, the main point of this invention will be having arranged the information signal which performed diffusion treatment of the direct spread system to DC subcarrier.
[0030]Hereafter, an embodiment of the invention is described in detail with reference to drawings.
[0031](Embodiment 1) First, direct current offset is reduced by the back-diffusion-of-gas processing at the time of reception, and the DS-CDMA information signal transmitted by DC subcarrier explains the point that error rate characteristics become good.
[0032]The case where DC offset exists is considered in a CDMA system. The DC offset after back-diffusion-of-gas processing is expressed by the formula shown below.
[Equation 1]

$$\sum_{n=1}^{N} \{DC \times REF(nT) / N\} \quad (n=1, 2, \cdots) \quad -①$$

However, DC is DC offset, REF (nT) is a spread code in the time nT, N is a diffusion ratio, and T is a sample cycle.
[0033]Here, generally, in the cycle (NT) of a spread code, since it can consider that DC offset is constant, upper type ** is expressed by the following formula.
[Equation 2]

$$DC\sum_{n=1}^{N}\{REF(nT)/N\}=DC\{(+1\text{の符号数})-(-1\text{の符号数})\}/N \quad -②$$

[0034]In the case of (signature of 1 [+]) -(signature of 1 [-]) =1, in upper type **, DC offset is decreased by back-diffusion-of-gas processing at 1/diffusion ratio. As for DC offset, (the signature of 1 [+]) and (the signature of -1) are thoroughly removed by back-diffusion-of-gas processing, when the same.
[0035]As mentioned above, in a CDMA system, since direct current offset is thoroughly removed by back-diffusion-of-gas processing, the error rate characteristics of a DS-CDMA information signal transmitted by DC subcarrier will become good.
[0036]Subsequently, an OFDM communication device concerning the embodiment of the invention 1 is explained with reference to drawing 1. Drawing 1 is a block diagram showing composition of an OFDM communication device concerning the embodiment of the invention 1. Here, a total of a subcarrier to be used is set to k (except for DS subcarrier) as an example.
[0037]With reference to drawing 1, the S/P converter 101 changes into an information signal of a plural series an information signal of one series which should be arranged to subcarriers other than DC subcarrier in a transmission system. The S/P converter 102 changes into an information signal of a plural series an information signal of one series which should be arranged to DC subcarrier.
[0038]The diffused part 103-1 - 103-n perform diffusion treatment to an information signal of a plural series. The adder unit 104 generates a DS-CDMA information signal by adding an information signal in which diffusion treatment was carried out by the diffused part 103-1 - 103-n. IFFT part 105 performs Frequency-Division-Multiplexing processing by performing IFFT processing to an information signal of a plural series from the S/P converter 101, and a DS-CDMA information signal from the adder unit 104. The antenna

106 receives a signal from a communications partner while transmitting a sending signal to a communications partner.
[0039]On the other hand, in a receiving system, FFT section 107 performs FFT processing to an input signal with which predetermined reception was made. The transmission-line compensation part 108-1 - 108-k perform transmission-line compensation processing (namely, processing which compensates distortion etc. which were produced in a transmission line) to an information signal transmitted by each subcarrier. The P/S converter 109 changes an information signal after the transmission-line compensation part 108-1 - transmission-line compensation processing from 108-k into an information signal of one series.
[0040]The transmission-line compensation part 110 performs transmission-line compensation processing (namely, processing which compensates distortion etc. which were produced in a transmission line) to a DS-CDMA information signal transmitted by DC subcarrier. The back-diffusion-of-gas part 111-1 - 111-n perform back-diffusion-of-gas processing using a spread code which is mutually different to a DS-CDMA information signal after transmission-line compensation processing. The P/S converter 112 changes an information signal of a plural series from the back-diffusion-of-gas part 111-1 - 111-n into an information signal of one series.
[0041]Subsequently, in addition to drawing 1, operation of an OFDM communication device of the above-mentioned composition is explained with reference to drawing 2. Drawing 2 is a mimetic diagram showing a situation of arrangement of a subcarrier in an OFDM communication device concerning the embodiment of the invention 1.
[0042]With reference to drawing 1, an information signal is sent to either the S/P converter 101 or the S/P converter 102 in a transmission system. An information signal sent to the S/P converter 101 is arranged at subcarriers other than DC subcarrier, and an information signal sent to the S/P converter 102 is arranged at DC subcarrier.
[0043]An information signal (information signal of one series) arranged at subcarriers other than DC subcarrier is changed into an information signal of a plural series of only the total subcarrier (except for DC subcarrier) by the S/P converter 101. That is, an information signal of one series is changed into k signals of the information signal 1 - the information signal k by the S/P converter 101. An information signal changed into a plural series is sent to IFFT part 105.
[0044]An information signal (information signal of one series) arranged at DC subcarrier is changed into an information signal of a plural series only for a predetermined signal multiplexed number (here, referred to as n as an example) by the S/P converter 102. That is, an information signal of one series is changed into n signals of the information signal 1 - the information signal n by the S/P converter 102. The above-mentioned signal multiplexed number can be set up arbitrarily.
[0045]The information signal 1 - the information signal n are sent to the adder unit 104, after diffusion treatment which used a spread code peculiar to a signal is performed by the diffused part 103-1 - diffused part 103-n, respectively. In the adder unit 104, a DS-CDMA information signal is generated by adding the information signal 1 - the information signal n after diffusion treatment. This DS-CDMA information signal is sent to IFFT part 105.
[0046]In IFFT part 105, Frequency-Division-Multiplexing processing is performed by making IFFT processing to an information signal of a plural series from the S/P converter

101, and a DS-CDMA information signal from the adder unit 104. By IFFT part 105, an information signal (namely, the information signal 1 - an information signal) changed into a plural series specifically, It arranges to a subcarrier for which only a number corresponding to the total number of subcarriers was prepared, a DS-CDMA information signal is arranged to DC subcarrier, and Frequency-Division-Multiplexing processing is performed. An example of a situation of assignment of a subcarrier is shown in drawing 2.

[0047]As shown in drawing 2, k subcarriers and one DC subcarrier are arranged on a frequency axis, A DS-CDMA information signal is assigned [at information signal k/2, and the subcarrier 1] to subcarrier k/2 to information signal k/2+1, and subcarrier k/2 in the information signal k and DC subcarrier at the information signal 1 and the subcarrier 1, respectively.

[0048]With reference to drawing 1, a signal with which Frequency-Division-Multiplexing processing in IFFT part 105 was overlapped on a subcarrier to the information signal 1 - the information signal k, and was overlapped on DC subcarrier to a DS-CDMA information signal is acquired again. A sending signal is generated by making predetermined transmitting processing to a signal acquired by Frequency-Division-Multiplexing processing. This sending signal is transmitted to a communications partner via the antenna 106. Parallel-serial-conversion processing, D/A conversion processing, frequency conversion processing, a band limiting process, etc. are included in the above-mentioned predetermined transmitting processing.

[0049]On the other hand, in a receiving system, a signal transmitted by communications partner is received by this communication apparatus via the antenna 106. The above-mentioned communications partner is provided with the same composition as what is shown in drawing 1, and transmits a sending signal acquired by performing processing in a transmission system mentioned above.

[0050]An input signal from the antenna 106 is sent to FFT section 107, after predetermined reception is made. A band limiting process, frequency conversion processing, A/D conversion processing, in-series parallel-conversion processing, etc. are included in the above-mentioned predetermined reception.

[0051]By performing FFT processing in FFT section 107 to an input signal with which the above-mentioned predetermined reception was made, An information signal (the information signal 1 - the information signal k) transmitted by subcarrier (except for DC subcarrier) and a DS-CDMA information signal transmitted by DC subcarrier are taken out.

[0052]The information signal 1 - the information signal k which were transmitted by subcarrier (except for DC subcarrier) are sent to the transmission-line compensation part 108-1 - 108-k, respectively. A DS-CDMA information signal transmitted by DC subcarrier is sent to the transmission-line compensation part 110.

[0053]In the transmission-line compensation part 108-1 - 108-k, transmission-line compensation processing is made to the information signal 1 - the information signal k which were transmitted by subcarrier, respectively. k information signals with which transmission-line compensation processing was made are changed into an information signal of one series by the P/S converter 109.

[0054]In the transmission-line compensation part 110, transmission-line compensation processing is made to a DS-CDMA information signal transmitted by DC subcarrier. A

DS-CDMA information signal after transmission-line compensation processing is sent to the back-diffusion-of-gas part 111-1 - 111-n.
[0055]In the back-diffusion-of-gas part 111-1 - 111-n, the information signal 1 - the information signal n are acquired by performing back-diffusion-of-gas processing using a spread code which is mutually different to a DS-CDMA information signal after transmission-line compensation processing. The information signal 1 - the information signal n which were acquired are changed into an information signal of one series by the P/S converter 112.
[0056]Transmission of an information signal is performed by making the above processings. In IFFT part 105 in a transmission system, a DS-CDMA information signal is arranged to DC subcarrier as above-mentioned. A DS-CDMA information signal transmitted by this DC subcarrier, Although influenced by direct current offset in analog circuitry used for a receiving system and a transmission system, direct current offset is reduced by the back-diffusion-of-gas processing by the back-diffusion-of-gas part 111-1 in a transmission system - 111-n, and let error rate characteristics be a good thing. That is, even if it arranges a subcarrier to DC, the error rate characteristics of an information signal can be kept good. Since an information signal is arranged to DC subcarrier, overall transmission efficiency can also be raised.
[0057]Thus, in [according to the OFDM communication device concerning this embodiment] a transmitting side device, In a receiving side device by arranging and transmitting an information signal which performed diffusion treatment of a direct spread system to DC subcarrier, Since an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a signal transmitted by DC subcarrier can be taken out, it becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.
[0058]Although this embodiment explained taking the case of a case where a signal multiplexed number is made into plurality, this invention is not limited to this, but also when a signal multiplexed number is set to 1, it can be applied. In this case, since one diffused part in drawing 1 is used, it is good also as composition which excluded the S/P converter 102 and the adder unit 104.
[0059]Although this embodiment explained a case where communication of an OFDM system was used, it cannot be overemphasized that it can apply also when this invention is not limited to this but communication of an OFDM-CDMA (Code Division Multiple Access) method is used. Specifically, the following processings may be performed to an information signal arranged to a subcarrier (except for DC subcarrier) with reference to drawing 1. That is, the above-mentioned information signal is changed into a signal of a plural series of only any number, and it may be made to send a signal which performed and added diffusion treatment peculiar to a signal to each signal to the S/P converter 101. Thereby, the error rate characteristics of an information signal transmitted by each subcarrier can be kept good.
[0060]An OFDM communication device explained by the above-mentioned embodiment can be carried in a communication terminal device and a base station device in a digital mobile communications system.
[0061]
[Effect of the Invention]As explained above, according to this invention, since the information signal which performed diffusion treatment of the direct spread system is

arranged to DC subcarrier, the OFDM communication device which raises transmission efficiency can be provided, suppressing the error rate characteristics of an information signal.

TECHNICAL FIELD

[Field of the Invention]This invention relates to the communication apparatus of an OFDM (Orthogonal Frequency Division Multiplexing) method especially about the communication apparatus used for a digital mobile communications system.

PRIOR ART

[Description of the Prior Art]These days, the communication apparatus (following "OFDM communication device") of the OFDM system is examined briskly. Hereafter, the conventional OFDM communication device is explained with reference to drawing 3. Drawing 3 is a block diagram showing the composition of the conventional OFDM communication device. Here, the total of the subcarrier (subcarrier) to be used is set to k as an example.

[0003]With reference to drawing 3, the information signal of one series (serial) is changed into the information signal of the plural series (parallel) of only the total subcarrier by the S/P converter 1 in a transmission system. That is, the information signal of one series is changed into k signals of the information signal 1 - the information signal k by the S/P converter 1. The information signal changed into the plural series is sent to the IFFT (Inverse Fast Fourier Transform) section 2.

[0004]In IFFT part 2, Frequency-Division-Multiplexing processing is performed by making IFFT (inverse Fourier transform) processing to the information signal of a plural series. Specifically by IFFT part 2, the subcarrier for which only the number corresponding to the total number of subcarriers was prepared is assigned to the information signal into which it was changed by the plural series (if it puts in another way). The information signal changed into the plural series is arranged to the subcarrier for which only the number corresponding to the total number of subcarriers was prepared, and Frequency-Division-Multiplexing processing is performed. How to assign a subcarrier is as being shown in drawing 4. Drawing 4 is a mimetic diagram showing the situation of arrangement of the subcarrier in the conventional OFDM communication device.

[0005]As shown in drawing 4, k subcarriers are arranged on the frequency axis and the information signal k is assigned to subcarrier k/2 to information signal k/2+1, and subcarrier k/2 at the information signal 1 and the subcarrier 1 at information signal k/2, and the subcarrier 1, respectively.

[0006]With reference to drawing 3, the signal with which the Frequency-Division-Multiplexing processing in IFFT part 2 was overlapped on the subcarrier to the information signal 1 - the information signal k is acquired again. A sending signal is generated by making predetermined transmitting processing to the signal acquired by Frequency-Division-Multiplexing processing. This sending signal is transmitted to a

communications partner via the antenna 3.
[0007]On the other hand, in a receiving system, the signal transmitted by the communications partner is received by this communication apparatus via the antenna 3. The above-mentioned communications partner is provided with the same composition as what is shown in drawing 3.
The sending signal acquired by performing processing in the transmission system mentioned above is transmitted.

[0008]The input signal from the antenna 3 is sent to the FFT (Fast Fourier Transform) section 4, after predetermined reception is made. In FFT section 4, the information signal (namely, k information signals) transmitted by each subcarrier is taken out by performing FFT (Fourier transform) processing to the input signal with which the above-mentioned predetermined reception was made.
[0009]The information signal transmitted by each subcarrier is sent to either of the transmission-line compensation parts (namely, the transmission-line compensation part 5-1 - 5-k) in which only the number corresponding to the total number of subcarriers was formed.
[0010]In the transmission-line compensation part 5-1 - 5-k, transmission-line compensation processing (namely, processing which compensates distortion etc. which were produced in the transmission line) is made to the information signal transmitted by each subcarrier. k information signals carried out after transmission-line compensation processing are changed into the information signal of one series (serial) by the P/S converter 6.
[0011]Transmission of an information signal is performed by making the above processings. Here, generally in IFFT part 2 in a transmission system, the subcarrier is not arranged to DC for the following reasons. That is, the subcarrier (henceforth "DC subcarrier (or direct-current subcarrier)") arranged at DC is overlapped on direct-current (DC) offset in the analog circuitry used for a transmission system and a receiving system. For this reason, the error characteristic of the information signal (namely, information signal transmitted by DC subcarrier) arranged at DC subcarrier deteriorates under the influence of direct current offset. For such a reason, as shown in drawing 4, the subcarrier is not arranged to DC.

EFFECT OF THE INVENTION

[Effect of the Invention]As explained above, in this invention, the information signal which performed diffusion treatment of the direct spread system is arranged to DC subcarrier.
Therefore, the OFDM communication device which raises transmission efficiency can be provided, suppressing the error rate characteristics of an information signal.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]However, there is a problem as shown below in the above-mentioned conventional OFDM communication device. Namely, although degradation of the error rate characteristics of an information signal can be prevented by making it not arrange a subcarrier to DC in the above-mentioned conventional OFDM communication device compared with the case where the subcarrier has been arranged, to DC, Transmission efficiency falls [the part which does not arrange a subcarrier to DC] compared with the case where the subcarrier has been arranged to DC.
[0013]This invention is made in view of this point, and is a thing.
The purpose is providing the OFDM communication device which raises transmission efficiency, suppressing error rate characteristics.

MEANS

[Means for Solving the Problem]An OFDM sending set of this invention takes composition possessing a creating means which generates a diffusion signal, and a Frequency-Division-Multiplexing means to perform Frequency-Division-Multiplexing processing by assigning said diffusion signal to a direct-current subcarrier, by performing diffusion treatment to an information signal.
[0015]A conversion method from which, as for an OFDM sending set of this invention, a creating means changes an information signal into a signal of a plural series in the above-mentioned composition, Composition possessing a diffusion means which performs diffusion treatment using a spread code peculiar to a signal to a signal of said plural series, and an adding means which generates a diffusion signal by adding a signal of said plural series in which diffusion treatment was carried out by said diffusion means is taken.
[0016]In a receiving side device by arranging and transmitting an information signal which performed diffusion treatment of a direct spread system to a direct-current subcarrier in a transmitting side device according to these composition, Since an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a signal transmitted by direct-current subcarrier can be taken out, it becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.
[0017]An OFDM receiving set of this invention by performing the Fourier conversion process to a signal received by reception means which receives a signal transmitted by an OFDM sending set of one of the above, and said reception means, Composition possessing the Fourier conversion process means which takes out a diffusion signal transmitted by direct-current subcarrier, and an extraction means to extract an information signal by performing back-diffusion-of-gas processing to a taken-out diffusion signal is taken.
[0018]In the above-mentioned composition, an extraction means an OFDM receiving set of this invention by performing back-diffusion-of-gas processing using a spread code peculiar to a signal to a diffusion signal taken out by the Fourier conversion process means, Composition possessing a back-diffusion-of-gas means to extract an information signal of a plural series, and a conversion method which changes an information signal of said plural series into an information signal of one series is taken.

[0019]When an information signal which performed diffusion treatment of a direct spread system performs the Fourier conversion process to a signal which has been arranged and was transmitted to a direct-current subcarrier according to these composition, Since a diffusion signal transmitted by direct-current subcarrier can be taken out and an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a taken-out diffusion signal further can be taken out, It becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.
[0020]A communication terminal device of this invention takes composition possessing an OFDM sending set of one of the above, and an OFDM receiving set of one of the above.
[0021]Since transmission efficiency can be raised according to this composition, suppressing the error rate characteristics of an information signal, a communication terminal device which performs good communication can be provided.
[0022]A base station device of this invention takes composition possessing an OFDM sending set of one of the above, and an OFDM receiving set of one of the above.
[0023]Since transmission efficiency can be raised according to this composition, suppressing the error rate characteristics of an information signal, a base station device which performs good communication can be provided.
[0024]An OFDM transmission method of this invention possessed a generation process of generating a diffusion signal, and a Frequency-Division-Multiplexing process of performing Frequency-Division-Multiplexing processing by assigning said diffusion signal to a direct-current subcarrier, by performing diffusion treatment to an information signal.
[0025]In a receiver by arranging and transmitting an information signal which performed diffusion treatment of a direct spread system to a direct-current subcarrier in the transmitting side according to this method, Since an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a signal transmitted by direct-current subcarrier can be taken out, it becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.
[0026]An OFDM receiving method of this invention by performing the Fourier conversion process to a receiving process which receives a signal transmitted by the above-mentioned OFDM transmission method, and a signal received in said receiving process, The Fourier conversion process process of taking out a diffusion signal transmitted by direct-current subcarrier, and an extraction process of extracting an information signal by performing back-diffusion-of-gas processing to a taken-out diffusion signal were provided.
[0027]When an information signal which performed diffusion treatment of a direct spread system performs the Fourier conversion process to a signal which has been arranged and was transmitted to a direct-current subcarrier according to this method, Since a diffusion signal transmitted by direct-current subcarrier can be taken out and an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a taken-out diffusion signal further can be taken out, It becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.

[0028]
[Embodiment of the Invention]First, this invention person noted performing diffusion treatment of a direct spread system to the information signal arranged to DC subcarrier. When this invention person has arranged the information signal to DC subcarrier, the error rate characteristics of the information signal transmitted by this DC subcarrier deteriorate, but. When the information signal (henceforth "a DS-CDMA information signal") which performed diffusion treatment of the direct spread system has been arranged to DC subcarrier, The DS-CDMA information signal transmitted by this DC subcarrier finds out that direct current offset is reduced by the back-diffusion-of-gas processing at the time of reception, and error rate characteristics will become good, and came to carry out this invention.
[0029]The main point of this invention is having been made to perform diffusion treatment of the direct spread system to the information signal arranged to DC subcarrier (direct-current subcarrier). If it puts in another way, the main point of this invention will be having arranged the information signal which performed diffusion treatment of the direct spread system to DC subcarrier.
[0030]Hereafter, an embodiment of the invention is described in detail with reference to drawings.
[0031](Embodiment 1) First, direct current offset is reduced by the back-diffusion-of-gas processing at the time of reception, and the DS-CDMA information signal transmitted by DC subcarrier explains the point that error rate characteristics become good.
[0032]The case where DC offset exists is considered in a CDMA system. The DC offset after back-diffusion-of-gas processing is expressed by the formula shown below.
[Equation 1]

$$\sum_{n=1}^{N}\{DC \times REF(nT) / N\} \quad (n=1, 2, \cdots) \quad \text{—①}$$

However, DC is DC offset, REF (nT) is a spread code in the time nT, N is a diffusion ratio, and T is a sample cycle.
[0033]Here, generally, in the cycle (NT) of a spread code, since it can consider that DC offset is constant, upper type ** is expressed by the following formula.
[Equation 2]

$$DC\sum_{n=1}^{N}\{REF(nT) / N\} = DC\{(+1\text{の符号数}) - (-1\text{の符号数})\} / N \quad \text{—②}$$

[0034]In the case of (signature of 1 [+]) -(signature of 1 [-]) =1, in upper type **, DC offset is decreased by back-diffusion-of-gas processing at 1/diffusion ratio. As for DC offset, (the signature of 1 [+]) and (the signature of -1) are thoroughly removed by back-diffusion-of-gas processing, when the same.
[0035]As mentioned above, in a CDMA system, since direct current offset is thoroughly removed by back-diffusion-of-gas processing, the error rate characteristics of the DS-CDMA information signal transmitted by DC subcarrier will become good.
[0036]Subsequently, the OFDM communication device concerning the embodiment of the invention 1 is explained with reference to drawing 1. Drawing 1 is a block diagram showing the composition of the OFDM communication device concerning the embodiment of the invention 1. Here, the total of the subcarrier to be used is set to k (except for DS subcarrier) as an example.

[0037]With reference to drawing 1, the S/P converter 101 changes into an information signal of a plural series an information signal of one series which should be arranged to subcarriers other than DC subcarrier in a transmission system. The S/P converter 102 changes into an information signal of a plural series an information signal of one series which should be arranged to DC subcarrier.
[0038]The diffused part 103-1 - 103-n perform diffusion treatment to an information signal of a plural series. The adder unit 104 generates a DS-CDMA information signal by adding an information signal in which diffusion treatment was carried out by the diffused part 103-1 - 103-n. IFFT part 105 performs Frequency-Division-Multiplexing processing by performing IFFT processing to an information signal of a plural series from the S/P converter 101, and a DS-CDMA information signal from the adder unit 104. The antenna 106 receives a signal from a communications partner while transmitting a sending signal to a communications partner.
[0039]On the other hand, in a receiving system, FFT section 107 performs FFT processing to an input signal with which predetermined reception was made. The transmission-line compensation part 108-1 - 108-k perform transmission-line compensation processing (namely, processing which compensates distortion etc. which were produced in a transmission line) to an information signal transmitted by each subcarrier. The P/S converter 109 changes an information signal after the transmission-line compensation part 108-1 - transmission-line compensation processing from 108-k into an information signal of one series.
[0040]The transmission-line compensation part 110 performs transmission-line compensation processing (namely, processing which compensates distortion etc. which were produced in a transmission line) to a DS-CDMA information signal transmitted by DC subcarrier. The back-diffusion-of-gas part 111-1 - 111-n perform back-diffusion-of-gas processing using a spread code which is mutually different to a DS-CDMA information signal after transmission-line compensation processing. The P/S converter 112 changes an information signal of a plural series from the back-diffusion-of-gas part 111-1 - 111-n into an information signal of one series.
[0041]Subsequently, in addition to drawing 1, operation of an OFDM communication device of the above-mentioned composition is explained with reference to drawing 2. Drawing 2 is a mimetic diagram showing a situation of arrangement of a subcarrier in an OFDM communication device concerning the embodiment of the invention 1.
[0042]With reference to drawing 1, an information signal is sent to either the S/P converter 101 or the S/P converter 102 in a transmission system. An information signal sent to the S/P converter 101 is arranged at subcarriers other than DC subcarrier, and an information signal sent to the S/P converter 102 is arranged at DC subcarrier.
[0043]An information signal (information signal of one series) arranged at subcarriers other than DC subcarrier is changed into an information signal of a plural series of only the total subcarrier (except for DC subcarrier) by the S/P converter 101. That is, an information signal of one series is changed into k signals of the information signal 1 - the information signal k by the S/P converter 101. An information signal changed into a plural series is sent to IFFT part 105.
[0044]An information signal (information signal of one series) arranged at DC subcarrier is changed into an information signal of a plural series only for a predetermined signal multiplexed number (here, referred to as n as an example) by the S/P converter 102. That

is, an information signal of one series is changed into n signals of the information signal 1 - the information signal n by the S/P converter 102. The above-mentioned signal multiplexed number can be set up arbitrarily.
[0045]The information signal 1 - the information signal n are sent to the adder unit 104, after diffusion treatment which used a spread code peculiar to a signal is performed by the diffused part 103-1 - diffused part 103-n, respectively. In the adder unit 104, a DS-CDMA information signal is generated by adding the information signal 1 - the information signal n after diffusion treatment. This DS-CDMA information signal is sent to IFFT part 105.
[0046]In IFFT part 105, Frequency-Division-Multiplexing processing is performed by making IFFT processing to an information signal of a plural series from the S/P converter 101, and a DS-CDMA information signal from the adder unit 104. By IFFT part 105, an information signal (namely, the information signal 1 - an information signal) changed into a plural series specifically, It arranges to a subcarrier for which only a number corresponding to the total number of subcarriers was prepared, a DS-CDMA information signal is arranged to DC subcarrier, and Frequency-Division-Multiplexing processing is performed. An example of a situation of assignment of a subcarrier is shown in drawing 2.
[0047]As shown in drawing 2, k subcarriers and one DC subcarrier are arranged on a frequency axis, A DS-CDMA information signal is assigned [at information signal k/2, and the subcarrier 1] to subcarrier k/2 to information signal k/2+1, and subcarrier k/2 in the information signal k and DC subcarrier at the information signal 1 and the subcarrier 1, respectively.
[0048]With reference to drawing 1, a signal with which Frequency-Division-Multiplexing processing in IFFT part 105 was overlapped on a subcarrier to the information signal 1 - the information signal k, and was overlapped on DC subcarrier to a DS-CDMA information signal is acquired again. A sending signal is generated by making predetermined transmitting processing to a signal acquired by Frequency-Division-Multiplexing processing. This sending signal is transmitted to a communications partner via the antenna 106. Parallel-serial-conversion processing, D/A conversion processing, frequency conversion processing, a band limiting process, etc. are included in the above-mentioned predetermined transmitting processing.
[0049]On the other hand, in a receiving system, a signal transmitted by communications partner is received by this communication apparatus via the antenna 106. The above-mentioned communications partner is provided with the same composition as what is shown in drawing 1, and transmits a sending signal acquired by performing processing in a transmission system mentioned above.
[0050]An input signal from the antenna 106 is sent to FFT section 107, after predetermined reception is made. A band limiting process, frequency conversion processing, A/D conversion processing, in-series parallel-conversion processing, etc. are included in the above-mentioned predetermined reception.
[0051]By performing FFT processing in FFT section 107 to an input signal with which the above-mentioned predetermined reception was made, An information signal (the information signal 1 - the information signal k) transmitted by subcarrier (except for DC subcarrier) and a DS-CDMA information signal transmitted by DC subcarrier are taken out.

[0052]The information signal 1 - the information signal k which were transmitted by subcarrier (except for DC subcarrier) are sent to the transmission-line compensation part 108-1 - 108-k, respectively. A DS-CDMA information signal transmitted by DC subcarrier is sent to the transmission-line compensation part 110.
[0053]In the transmission-line compensation part 108-1 - 108-k, transmission-line compensation processing is made to the information signal 1 - the information signal k which were transmitted by subcarrier, respectively. k information signals with which transmission-line compensation processing was made are changed into an information signal of one series by the P/S converter 109.
[0054]In the transmission-line compensation part 110, transmission-line compensation processing is made to a DS-CDMA information signal transmitted by DC subcarrier. A DS-CDMA information signal after transmission-line compensation processing is sent to the back-diffusion-of-gas part 111-1 - 111-n.
[0055]In the back-diffusion-of-gas part 111-1 - 111-n, the information signal 1 - the information signal n are acquired by performing back-diffusion-of-gas processing using a spread code which is mutually different to a DS-CDMA information signal after transmission-line compensation processing. The information signal 1 - the information signal n which were acquired are changed into an information signal of one series by the P/S converter 112.
[0056]Transmission of an information signal is performed by making the above processings. In IFFT part 105 in a transmission system, a DS-CDMA information signal is arranged to DC subcarrier as above-mentioned. A DS-CDMA information signal transmitted by this DC subcarrier, Although influenced by direct current offset in analog circuitry used for a receiving system and a transmission system, direct current offset is reduced by the back-diffusion-of-gas processing by the back-diffusion-of-gas part 111-1 in a transmission system - 111-n, and let error rate characteristics be a good thing. That is, even if it arranges a subcarrier to DC, the error rate characteristics of an information signal can be kept good. Since an information signal is arranged to DC subcarrier, overall transmission efficiency can also be raised.
[0057]Thus, in [according to the OFDM communication device concerning this embodiment] a transmitting side device, In a receiving side device by arranging and transmitting an information signal which performed diffusion treatment of a direct spread system to DC subcarrier, Since an information signal which reduced direct current offset by performing back-diffusion-of-gas processing to a signal transmitted by DC subcarrier can be taken out, it becomes possible to raise transmission efficiency, suppressing the error rate characteristics of an information signal.
[0058]Although this embodiment explained taking the case of a case where a signal multiplexed number is made into plurality, this invention is not limited to this, but also when a signal multiplexed number is set to 1, it can be applied. In this case, since one diffused part in drawing 1 is used, it is good also as composition which excluded the S/P converter 102 and the adder unit 104.
[0059]Although this embodiment explained a case where communication of an OFDM system was used, it cannot be overemphasized that it can apply also when this invention is not limited to this but communication of an OFDM-CDMA (Code Division Multiple Access) method is used. Specifically, the following processings may be performed to an information signal arranged to a subcarrier (except for DC subcarrier) with reference to

drawing 1. That is, the above-mentioned information signal is changed into a signal of a plural series of only any number, and it may be made to send a signal which performed and added diffusion treatment peculiar to a signal to each signal to the S/P converter 101. Thereby, the error rate characteristics of an information signal transmitted by each subcarrier can be kept good.

[0060]An OFDM communication device explained by the above-mentioned embodiment can be carried in a communication terminal device and a base station device in a digital mobile communications system.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]The block diagram showing the composition of the OFDM communication device concerning the embodiment of the invention 1

[Drawing 2]The mimetic diagram showing the situation of arrangement of the subcarrier in the OFDM communication device concerning the embodiment of the invention 1

[Drawing 3]The block diagram showing the composition of the conventional OFDM communication device

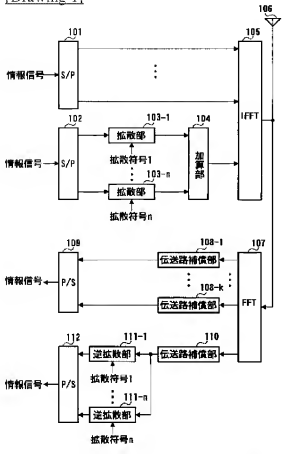
[Drawing 4]The mimetic diagram showing the situation of arrangement of the subcarrier in the conventional OFDM communication device

[Description of Notations]

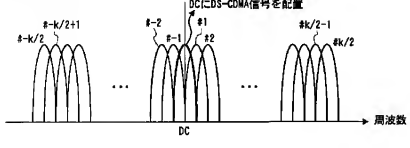
102 S/P converter
105 IFFT part
106 Antenna
107 FFT section
110 Transmission-line compensation part
111-1-111-n Back-diffusion-of-gas part
112 P/S converter

DRAWINGS

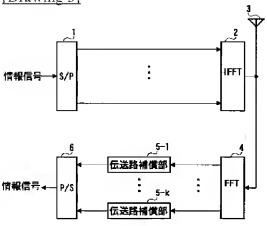
[Drawing 1]



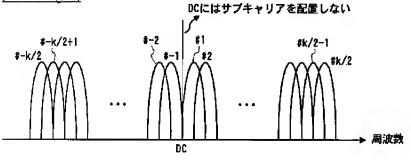
[Drawing 2]



[Drawing 3]



[Drawing 4]



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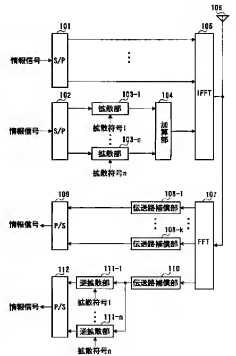
EE01 EE22 EE32

(54)【発明の名称】　ＯＦＤＭ通信装置およびＯＦＤＭ通信方法

(57)【要約】
【課題】　情報信号の誤り率特性を抑えつつ伝送効率を向上させること。
【解決手段】　拡散部１０３－１～１０３－ｎは、Ｓ／Ｐ１０２からの複数系列の情報信号に対して拡散処理を行う。加算部１０４は、拡散部１０３－１～１０３－ｎからの拡散処理後の信号を加算することにより、ＤＳ－ＣＤＭＡ情報信号を生成する。ＩＦＦＴ部１０５は、生成されたＤＳ－ＣＤＭＡ情報信号をＤＳサブキャリアに割り当てて周波数分割多重処理を行う。



【特許請求の範囲】
【請求項１】　情報信号に対して拡散処理を行うことにより拡散信号を生成する生成手段と、前記拡散信号を直流搬送波に割り当てることにより周波数分割多重処理を行う周波数分割多重手段と、を具備することを特徴とするＯＦＤＭ送信装置。
【請求項２】　生成手段は、情報信号を複数系列の信号に変換する変換手段と、前記複数系列の信号に対して信号固有の拡散符号を用いた拡散処理を行う拡散手段と、前記拡散手段により拡散処理された前記複数系列の信号を加算することにより拡散信号を生成する加算手段と、を具備することを特徴とする請求項１に記載のＯＦＤＭ送信装置。
【請求項３】　請求項１または請求項２に記載のＯＦＤＭ送信装置により送信された信号を受信する受信手段と、前記受信手段により受信された信号に対してフーリエ変換処理を行うことにより、直流搬送波により伝送された拡散信号を取り出すフーリエ変換処理手段と、取り出された拡散信号に対して逆拡散処理を行うことにより情報信号を抽出する抽出手段と、を具備することを特徴とするＯＦＤＭ受信装置。
【請求項４】　抽出手段は、フーリエ変換処理手段により取り出された拡散信号に対して信号固有の拡散符号を用いた逆拡散処理を行うことにより、複数系列の情報信号を抽出する逆拡散手段と、前記複数系列の情報信号を一系列の情報信号に変換する変換手段と、を具備することを特徴とする請求項３に記載のＯＦＤＭ受信装置。
【請求項５】　請求項１または請求項２に記載のＯＦＤＭ送信装置と、請求項３または請求項４に記載のＯＦＤＭ受信装置と、を具備することを特徴とする通信端末装置。
【請求項６】　請求項１または請求項２に記載のＯＦＤＭ送信装置と、請求項３または請求項４に記載のＯＦＤＭ受信装置と、を具備することを特徴とする基地局装置。
【請求項７】　情報信号に対して拡散処理を行うことにより拡散信号を生成する生成工程と、前記拡散信号を直流搬送波に割り当てることにより周波数分割多重処理を行う周波数分割多重工程と、を具備することを特徴とするＯＦＤＭ送信方法。
【請求項８】　請求項７に記載のＯＦＤＭ送信方法により送信された信号を受信する受信工程と、前記受信工程において受信された信号に対してフーリエ変換処理を行うことにより、直流搬送波により伝送された拡散信号を取り出すフーリエ変換処理工程と、取り出された拡散信号に対して逆拡散処理を行うことにより情報信号を抽出する抽出工程と、を具備することを特徴とするＯＦＤＭ受信方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、ディジタル移動体通信システムに用いられる通信装置に関し、特に、ＯＦＤＭ（Orthogonal Frequency Division Multiplexing）方式の通信装置に関する。
【０００２】
【従来の技術】最近、ＯＦＤＭ方式の通信装置（以下「ＯＦＤＭ通信装置」）が盛んに検討されている。以下、従来のＯＦＤＭ通信装置について、図３を参照して説明する。図３は、従来のＯＦＤＭ通信装置の構成を示すブロック図である。ここでは、一例として、用いるサブキャリア（搬送波）の総数をｋとする。
【０００３】図３を参照するに、送信系において、一系列（シリアル）の情報信号は、Ｓ／Ｐ変換器１により総サブキャリアだけの複数系列（パラレル）の情報信号に変換される。すなわち、一系列の情報信号は、Ｓ／Ｐ変換器１により情報信号１～情報信号ｋの｛個の信号に変換される。複数系列に変換された情報信号は、ＩＦＦＴ（Inverse Fast Fourier Transform）部２に送られる。
【０００４】ＩＦＦＴ部２では、複数系列の情報信号に対してＩＦＦＴ（逆フーリエ変換）処理がなされることにより、周波数分割多重処理が行われる。具体的には、ＩＦＦＴ部２では、総サブキャリア数に対応する数だけ用意されたサブキャリアを、複数系列に変換された情報信号に対して割り当てて（換言すれば、複数系列に変換された情報信号を、総サブキャリア数に対応する数だけ用意されたサブキャリアに対して配置して）、周波数分割多重処理が行われる。サブキャリアの割り当て方法は、図４に示す通りである。図４は、従来のＯＦＤＭ通信装置におけるサブキャリアの配置の様子を示す模式図である。
【０００５】図４に示すように、周波数軸上にｋ個のサブキャリアが配置されており、サブキャリア－ｋ／２には情報信号１、サブキャリア－１には情報信号ｋ／２、サブキャリア１には情報信号ｋ／２＋１、サブキャリアｋ／２には情報信号ｋがそれぞれ割り当てられている。
【０００６】再度図３を参照するに、ＩＦＦＴ部２における周波数分割多重処理により、情報信号１～情報信号ｋに対してサブキャリアが重畳された信号が得られる。周波数分割多重処理により得られた信号に対して所定の送信処理がなされることにより、送信信号が生成される。この送信信号は、アンテナ３を介して通信相手に対して送信される。
【０００７】一方、受信系において、通信相手により送信された信号は、アンテナ３を介して、本通信装置により受信される。なお、上記通信相手は、図３に示すものと同様の構成を備えており、上述した送信系における処理を行うことにより得られる送信信号を送信するものである。
【０００８】アンテナ３からの受信信号は、所定の受信処理がなされた後、ＦＦＴ（Fast Fourier Transform）

部４に送られる。ＦＦＴ部４では、上記所定の受信処理がなされた受信信号に対してＦＦＴ（フーリエ変換）処理が行われることにより、各サブキャリアにより伝送された情報信号（すなわちｋ個の情報信号）が取り出される。

【０００９】各サブキャリアにより伝送された情報信号は、総サブキャリア数に対応する数だけ設けられた伝送路補償部（すなわち伝送路補償部５－１～５－ｋ）のいずれかに送られる。

【００１０】伝送路補償部５－１～５－ｋでは、各サブキャリアにより伝送された情報信号に対して、伝送路補償処理（すなわち伝送路で生じた歪等を補償する処理）がなされる。伝送路補償処理後されたｋ個の情報信号は、Ｐ／Ｓ変換器６により一系列（シリアル）の情報信号に変換される。

【００１１】以上のような処理がなされることにより、情報信号の伝送が実行される。ここで、送信系におけるＩＦＦＴ部２において、一般に、以下のような理由によりＤＣにはサブキャリアを配置していない。すなわち、ＤＣに配置されたサブキャリア（以下「ＤＣサブキャリア（または直流搬送波）」という。）には、送信系および受信系に用いられるアナログ回路において直流（ＤＣ）オフセットが重畳される。このため、ＤＣサブキャリアに配置された情報信号（すなわち、ＤＣサブキャリアにより伝送された情報信号）の誤り特性は、直流オフセットの影響により劣化する。このような理由により、図４に示したように、ＤＣにはサブキャリアを配置していない。

【００１２】

【発明が解決しようとする課題】しかしながら、上記従来のＯＦＤＭ通信装置においては、以下に示すような問題がある。すなわち、上記従来のＯＦＤＭ通信装置においては、ＤＣにサブキャリアを配置しないようにすることにより、ＤＣにサブキャリアを配置した場合に比べて、情報信号の誤り率特性の劣化を防ぐことができるが、ＤＣにサブキャリアを配置した場合に比べて、ＤＣにサブキャリアを配置しない分だけ伝送効率は低下する。

【００１３】本発明は、かかる点に鑑みてなされたものであり、情報信号の誤り率特性を抑えつつ伝送効率を向上させるＯＦＤＭ通信装置を提供することを目的とする。

【００１４】

【課題を解決するための手段】本発明のＯＦＤＭ送信装置は、情報信号に対して拡散処理を行うことにより拡散信号を生成する生成手段と、前記拡散信号を直流搬送波に割り当てることにより周波数分割多重処理を行う周波数分割多重手段と、を具備する構成を採る。

【００１５】本発明のＯＦＤＭ送信装置は、上記構成において、生成手段が、情報信号を複数系列の信号に変換する変換手段と、前記複数系列の信号に対して信号固有の拡散符号を用いた拡散処理を行う拡散手段と、前記拡散手段により拡散処理された前記複数系列の信号を加算することにより拡散信号を生成する加算手段と、を具備する構成を採る。

【００１６】これらの構成によれば、送信側装置において、直接拡散方式の拡散処理を施した情報信号を直流搬送波に配置して送信することにより、受信側装置においては、直流搬送波により伝送された信号に対して逆拡散処理を施すことにより、直流オフセットを低減させた情報信号を取り出すことができるので、情報信号の誤り率特性を抑えつつ伝送効率を向上させることが可能となる。

【００１７】本発明のＯＦＤＭ受信装置は、上記いずれかのＯＦＤＭ送信装置により送信された信号を受信する受信手段と、前記受信手段により受信された信号に対してフーリエ変換処理を行うことにより、直流搬送波により伝送された拡散信号を取り出すフーリエ変換処理手段と、取り出された拡散信号に対して逆拡散処理を行うことにより情報信号を抽出する抽出手段と、を具備する構成を採る。

【００１８】本発明のＯＦＤＭ受信装置は、上記構成において、抽出手段が、フーリエ変換処理手段により取り出された拡散信号に対して信号固有の拡散符号を用いた逆拡散処理を行うことにより、複数系列の情報信号を抽出する逆拡散手段と、前記複数系列の情報信号を一系列の情報信号に変換する変換手段と、を具備する構成を採る。

【００１９】これらの構成によれば、直接拡散方式の拡散処理を施した情報信号が直流搬送波に配置されて送信された信号に対してフーリエ変換処理を行うことにより、直流搬送波により伝送された拡散信号を取り出すことができ、さらに、取り出された拡散信号に対して逆拡散処理を施すことにより、直流オフセットを低減させた情報信号を取り出すことができるので、情報信号の誤り率特性を抑えつつ伝送効率を向上させることが可能となる。

【００２０】本発明の通信端末装置は、上記いずれかのＯＦＤＭ送信装置と、上記いずれかのＯＦＤＭ受信装置と、を具備する構成を採る。

【００２１】この構成によれば、情報信号の誤り率特性を抑えつつ伝送効率を向上させることができるので、良好な通信を行う通信端末装置を提供することができる。

【００２２】本発明の基地局装置は、上記いずれかのＯＦＤＭ送信装置と、上記いずれかのＯＦＤＭ受信装置と、を具備する構成を採る。

【００２３】この構成によれば、情報信号の誤り率特性を抑えつつ伝送効率を向上させることができるので、良好な通信を行う基地局装置を提供することができる。

【００２４】本発明のＯＦＤＭ送信方法は、情報信号に

対して拡散処理を行うことにより拡散信号を生成する生成工程と、前記拡散信号を直流搬送波に割り当てることにより周波数分割多重処理を行う周波数分割多重工程と、を具備するようにした。

【００２５】この方法によれば、送信側において、直接拡散方式の拡散処理を施した情報信号を直流搬送波に配置して送信することにより、受信側においては、直流搬送波により伝送された信号に対して逆拡散処理を施すことにより、直流オフセットを低減させた情報信号を取り出すことができるので、情報信号の誤り率特性を抑えつつ伝送効率を向上させることが可能となる。

【００２６】本発明のＯＦＤＭ受信方法は、上記ＯＦＤＭ送信方法により送信された信号を受信する受信工程と、前記受信工程において受信された信号に対してフーリエ変換処理を行うことにより、直流搬送波により伝送された拡散信号を取り出すフーリエ変換処理工程と、取り出された拡散信号に対して逆拡散処理を行うことにより情報信号を抽出する抽出工程と、を具備するようにした。

【００２７】この方法によれば、直接拡散方式の拡散処理を施した情報信号が直流搬送波に配置されて送信された信号に対してフーリエ変換処理を行うことにより、直流搬送波により伝送された拡散信号を取り出すことができ、さらに、取り出された拡散信号に対して逆拡散処理を施すことにより、直流オフセットを低減させた情報信号を取り出すことができるので、情報信号の誤り率特性を抑えつつ伝送効率を向上させることが可能となる。

【００２８】

【発明の実施の形態】まず、本発明者は、ＤＣサブキャリアに配置する情報信号に対して直接拡散方式の拡散処理を施すことに着目した。さらに、本発明者は、ＤＣサブキャリアに対して情報信号を配置した場合には、このＤＣサブキャリアにより伝送された情報信号の誤り率特性は劣化するが、ＤＣサブキャリアに対して、直接拡散方式の拡散処理を施した情報信号（以下「ＤＳ－ＣＤＭＡ情報信号」という。）を配置した場合には、このＤＣサブキャリアにより伝送されたＤＳ－ＣＤＭＡ情報信号は、受信時における逆拡散処理により、直流オフセットが低減されて誤り率特性が良好なものとなることを見出し、本発明をするに至った。

【００２９】本発明の骨子は、ＤＣサブキャリア（直流搬送波）に配置する情報信号に対して、直接拡散方式の拡散処理を施すようにしたことである。換言すれば、本発明の骨子は、直接拡散方式の拡散処理を施した情報信号をＤＣサブキャリアに配置するようにしたことである。

【００３０】以下、本発明の実施の形態について、図面を参照して詳細に説明する。

【００３１】（実施の形態１）まず最初に、ＤＣサブキャリアにより伝送されたＤＳ－ＣＤＭＡ情報信号が、受信時における逆拡散処理により直流オフセットが低減されて誤り率特性が良好となる点について説明する。

【００３２】ＣＤＭＡ方式において、ＤＣオフセットが存在する場合を考える。逆拡散処理後のＤＣオフセットは、次に示す式により表現される。

【数１】

$$\sum_{n=1}^{N}\{DC\times REF(nT)/N\}\quad(n=1,2,\cdots)\qquad\text{—①}$$

ただし、ＤＣはＤＣオフセットであり、ＲＥＦ（ｎＴ）は時刻ｎＴにおける拡散符号であり、Ｎは拡散比であり、Ｔはサンプル周期である。

【００３３】ここで、一般に、拡散符号の周期（ＮＴ）においては、ＤＣオフセットは一定であるとみなすことができるので、上式①は次式により表現される。

【数２】

$$DC\sum_{n=1}^{N}\{REF(nT)/N\}=DC\{(+1の符号数)-(-1の符号数)\}/N\qquad\text{—②}$$

【００３４】上式②において、（＋１の符号数）－（－１の符号数）＝１の場合には、ＤＣオフセットは、逆拡散処理により１／拡散比に減衰される。また、（＋１の符号数）と（－１の符号数）が同じである場合には、ＤＣオフセットは逆拡散処理により完全に除去される。

【００３５】以上のように、ＣＤＭＡ方式においては、直流オフセットは逆拡散処理により完全に除去されるので、ＤＣサブキャリアにより伝送されるＤＳ－ＣＤＭＡ情報信号の誤り率特性は良好なものとなる。

【００３６】次いで、本発明の実施の形態１にかかるＯＦＤＭ通信装置について、図１を参照して説明する。図１は、本発明の実施の形態１にかかるＯＦＤＭ通信装置の構成を示すブロック図である。なお、ここでは、一例として、用いるサブキャリアの総数をｋ（ＤＳサブキャリアを除く）とする。

※【００３７】図１を参照するに、送信系において、Ｓ／Ｐ変換器１０１は、ＤＣサブキャリア以外のサブキャリアに配置すべき一系列の情報信号を複数系列の情報信号に変換するものである。Ｓ／Ｐ変換器１０２は、ＤＣサブキャリアに配置すべき一系列の情報信号を複数系列の情報信号に変換するものである。

【００３８】拡散部１０３－１～１０３－ｎは、複数系列の情報信号に対して拡散処理を行うものである。加算部１０４は、拡散部１０３－１～１０３－ｎにより拡散処理された情報信号を加算することにより、ＤＳ－ＣＤＭＡ情報信号を生成するものである。ＩＦＦＴ部１０５は、Ｓ／Ｐ変換器１０１からの複数系列の情報信号、および、加算部１０４からのＤＳ－ＣＤＭＡ情報信号に対して、ＩＦＦＴ処理を行うことにより、周波数分割多重処理を行うものである。アンテナ１０６は、送信信号を

通信相手に対して送信するとともに、通信相手からの信号を受信するものである。

【００３９】一方、受信系において、ＦＦＴ部１０７は、所定の受信処理がなされた受信信号に対してＦＦＴ処理を行うものである。伝送路補償部１０８－１～１０８－ｋは、各サブキャリアにより伝送された情報信号に対して、伝送路補償処理（すなわち伝送路で生じた歪等を補償する処理）を行うものである。Ｐ／Ｓ変換器１０９は、伝送路補償部１０８－１～１０８－ｋからの伝送路補償処理後の情報信号を一系列の情報信号に変換するものである。

【００４０】伝送路補償部１１０は、ＤＣサブキャリアにより伝送されたＤＳ－ＣＤＭＡ情報信号に対して、伝送路補償処理（すなわち伝送路で生じた歪等を補償する処理）を行うものである。逆拡散部１１１－１～１１１－ｎは、伝送路補償処理後のＤＳ－ＣＤＭＡ情報信号に対して、相互に異なる拡散符号を用いた逆拡散処理を行うものである。Ｐ／Ｓ変換器１１２は、逆拡散部１１１－１～１１１－ｎからの複数系列の情報信号を一系列の情報信号に変換するものである。

【００４１】次いで、上記構成のＯＦＤＭ通信装置の動作について、図１に加えて図２を参照して説明する。図２は、本発明の実施の形態１にかかるＯＦＤＭ通信装置におけるサブキャリアの配置の様子を示す模式図である。

【００４２】図１を参照するに、送信系において、情報信号は、Ｓ／Ｐ変換器１０１またはＳ／Ｐ変換器１０２のいずれかに送られる。Ｓ／Ｐ変換器１０１に送られる情報信号は、ＤＣサブキャリア以外のサブキャリアに配置されるものであり、Ｓ／Ｐ変換器１０２に送られる情報信号は、ＤＣサブキャリアに配置されるものである。

【００４３】ＤＣサブキャリア以外のサブキャリアに配置される情報信号（一系列の情報信号）は、Ｓ／Ｐ変換器１０１により総サブキャリア（ＤＣサブキャリアを除く）だけの複数系列の情報信号に変換される。すなわち、一系列の情報信号は、Ｓ／Ｐ変換器１０１により情報信号１～情報信号ｋのｋ個の信号に変換される。複数系列に変換された情報信号は、ＩＦＦＴ部１０５に送られる。

【００４４】ＤＣサブキャリアに配置される情報信号（一系列の情報信号）は、Ｓ／Ｐ変換器１０２により、所定の信号多重数分（ここでは一例としてｎとする）だけの複数系列の情報信号に変換される。すなわち、一系列の情報信号は、Ｓ／Ｐ変換器１０２により、情報信号１～情報信号ｎのｎ個の信号に変換される。なお、上記信号多重数は任意に設定可能なものである。

【００４５】情報信号１～情報信号ｎは、それぞれ、拡散部１０３－１～拡散部１０３－ｎにより、信号固有の拡散符号を用いた拡散処理が施された後、加算部１０４に送られる。加算部１０４においては、拡散処理後の情報信号１～情報信号ｎが加算されることにより、ＤＳ－ＣＤＭＡ情報信号が生成される。このＤＳ－ＣＤＭＡ情報信号は、ＩＦＦＴ部１０５に送られる。

【００４６】ＩＦＦＴ部１０５では、Ｓ／Ｐ変換器１０１からの複数系列の情報信号、および、加算部１０４からのＤＳ－ＣＤＭＡ情報信号に対して、ＩＦＦＴ処理がなされることにより、周波数分割多重処理が行われる。具体的には、ＩＦＦＴ部１０５では、複数系列に変換された情報信号（すなわち情報信号１～情報信号）を、総サブキャリア数に対応する数だけ用意されたサブキャリアに対して配置し、ＤＳ－ＣＤＭＡ情報信号をＤＣサブキャリアに対して配置して、周波数分割多重処理が行われる。サブキャリアの割り当ての様子の一例を図２に示す。

【００４７】図２に示すように、周波数軸上にｋ個のサブキャリアおよび１個のＤＣサブキャリアが配置されており、サブキャリアｋ／２には情報信号１、サブキャリア－１には情報信号ｋ／２、サブキャリア１には情報信号ｋ／２＋１、サブキャリアＫ／２には情報信号ｋ、ＤＣサブキャリアにはＤＳ－ＣＤＭＡ情報信号がそれぞれ割り当てられている。

【００４８】再度図１を参照するに、ＩＦＦＴ部１０５における周波数分割多重処理により、情報信号１～情報信号ｋに対してサブキャリアが重畳され、ＤＳ－ＣＤＭＡ情報信号に対してＤＣサブキャリアが重畳された信号が得られる。周波数分割多重処理により得られた信号に対して所定の送信処理がなされることにより、送信信号が生成される。この送信信号は、アンテナ１０６を介して通信相手に対して送信される。なお、上記所定の送信処理には、並列直列変換処理、Ｄ／Ａ変換処理、周波数変換処理および帯域制限処理等が含まれる。

【００４９】一方、受信系において、通信相手により送信された信号は、アンテナ１０６を介して、本通信装置により受信される。なお、上記通信相手は、図１に示すものと同様の構成を備えており、上述した送信系における処理を行うことにより得られる送信信号を送信するものである。

【００５０】アンテナ１０６からの受信信号は、所定の受信処理がなされた後、ＦＦＴ部１０７に送られる。なお、上記所定の受信処理には、帯域制限処理、周波数変換処理、Ａ／Ｄ変換処理および直列並列変換処理等が含まれる。

【００５１】ＦＦＴ部１０７では、上記所定の受信処理がなされた受信信号に対してＦＦＴ処理が行われることにより、サブキャリア（ＤＣサブキャリアを除く）により伝送された情報信号（情報信号１～情報信号ｋ）、および、ＤＣサブキャリアにより伝送されたＤＳ－ＣＤＭＡ情報信号が取り出される。

【００５２】サブキャリア（ＤＣサブキャリアを除く）により伝送された情報信号１～情報信号ｋは、それぞ

れ、伝送路補償部１０８－１～１０８－ｋに送られる。ＤＣサブキャリアにより伝送されたＤＳ－ＣＤＭＡ情報信号は、伝送路補償部１１０に送られる。

【００５３】伝送路補償部１０８－１～１０８－ｋでは、それぞれ、サブキャリアにより伝送された情報信号１～情報信号ｋに対して、伝送路補償処理がなされる。伝送路補償処理がなされたｋ個の情報信号は、Ｐ／Ｓ変換器１０９により一系列の情報信号に変換される。

【００５４】伝送路補償部１１０では、ＤＣサブキャリアにより伝送されたＤＳ－ＣＤＭＡ情報信号に対して、伝送路補償処理がなされる。伝送路補償処理後のＤＳ－ＣＤＭＡ情報信号は、逆拡散部１１１－１～１１１－ｎに送られる。

【００５５】逆拡散部１１１－１～１１１－ｎでは、伝送路補償処理後のＤＳ－ＣＤＭＡ情報信号に対して、相互に異なる拡散符号を用いた逆拡散処理が行われることにより、情報信号１～情報信号ｎが得られる。得られた情報信号１～情報信号ｎは、Ｐ／Ｓ変換器１１２により一系列の情報信号に変換される。

【００５６】以上のような処理がなされることにより、情報信号の伝送が実行される。上述の通り、送信系におけるＩＦＦＴ部１０５においては、ＤＣサブキャリアに対してＤＳ－ＣＤＭＡ情報信号を配置している。このＤＣサブキャリアにより伝送されるＤＳ－ＣＤＭＡ情報信号は、受信系および送信系に用いられるアナログ回路において直流オフセットの影響を受けるものの、送信系における逆拡散部１１１－１～１１１－ｎでの逆拡散処理により、直流オフセットが低減されて誤り率特性が良好なものとされる。すなわち、ＤＣにサブキャリアを配置しても、情報信号の誤り率特性を良好に保つことができる。さらに、ＤＣサブキャリアに情報信号を配置しているので、全体的な伝送効率を向上させることもできる。

【００５７】このように、本実施の形態にかかるＯＦＤＭ通信装置によれば、送信側装置において、直接拡散方式の拡散処理を施した情報信号をＤＣサブキャリアに配置して送信することにより、受信側装置においては、ＤＣサブキャリアにより伝送された信号に対して逆拡散処理を施すことにより、直流オフセットを低減させた情報信号を取り出すことができるので、情報信号の誤り率特性を抑えつつ伝送効率を向上させることが可能となる。

【００５８】なお、本実施の形態では、信号多重数を複数とした場合を例にとり説明したが、本発明は、これに限定されず、信号多重数を１とした場合にも適用可能なものである。この場合には、図１における拡散部を１つのみ用いるので、Ｓ／Ｐ変換器１０２および加算部１０４を省いた構成としてもよい。

【００５９】また、本実施の形態では、ＯＦＤＭ方式の通信を用いた場合について説明したが、本発明は、これに限定されず、ＯＦＤＭ－ＣＤＭＡ（Code Division Multiple Access）方式の通信を用いた場合にも適用可能であることは言うまでもない。具体的には、図１を参照するに、サブキャリア（ＤＣサブキャリアを除く）に配置する情報信号に対して、次のような処理を施してもよい。すなわち、上記情報信号を任意数だけの複数系列の信号に変換し、各信号に対して信号固有の拡散処理を施して加算した信号を、Ｓ／Ｐ変換器１０１に送るようにしてもよい。これにより、各サブキャリアにより伝送された情報信号の誤り率特性を良好に保つことができる。

【００６０】上記実施の形態で説明したＯＦＤＭ通信装置は、ディジタル移動体通信システムにおける通信端末装置や基地局装置に搭載可能なものである。

【００６１】

【発明の効果】以上説明したように、本発明によれば、直接拡散方式の拡散処理を施した情報信号をＤＣサブキャリアに配置するので、情報信号の誤り率特性を抑えつつ伝送効率を向上させるＯＦＤＭ通信装置を提供することができる。

【図面の簡単な説明】

【図１】本発明の実施の形態１にかかるＯＦＤＭ通信装置の構成を示すブロック図

【図２】本発明の実施の形態１にかかるＯＦＤＭ通信装置におけるサブキャリアの配置の様子を示す模式図

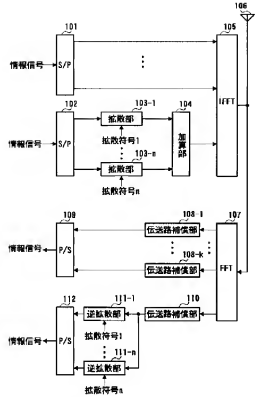
【図３】従来のＯＦＤＭ通信装置の構成を示すブロック図

【図４】従来のＯＦＤＭ通信装置におけるサブキャリアの配置の様子を示す模式図

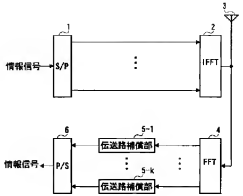
【符号の説明】

１０２　Ｓ／Ｐ変換器
１０５　ＩＦＦＴ部
１０６　アンテナ
１０７　ＦＦＴ部
１１０　伝送路補償部
１１１－１～１１１－ｎ　逆拡散部
１１２　Ｐ／Ｓ変換器

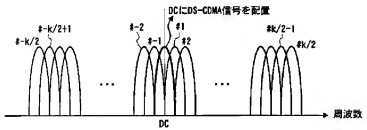
【図1】


106
101
105
情報信号
S/P
IFFT
102
103-1
104
拡散部
拡散符号1
加算部
103-n
拡散部
拡散符号n
109
108-1
107
伝送路補償部
108-k
伝送路補償部
FFT
112
111-1
110
逆拡散部
伝送路補償部
拡散符号1
111-n
逆拡散部
拡散符号n

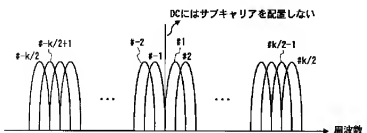
【図3】


3
1
2
情報信号
S/P
IFFT
6
5-1
4
伝送路補償部
P/S
FFT
5-k
伝送路補償部

【図2】


DCにDS-CDMA信号を配置
#-k/2+1
#-k/2
#-2
#-1
#1
#2
#k/2-1
#k/2
周波数
DC

【図4】


DCにはサブキャリアを配置しない
#-k/2+1
#-k/2
#-2
#-1
#1
#2
#k/2-1
#k/2
周波数
DC